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ABSTRACT

Guidelines and recommendations for teacher education recommended by the American Chemistry Society are presented. The guidelines for preservice and inservice education of chemistry and science teachers are also included. Suggestions for implementing the teacher education programs are specified for teachers, college and university administrators and faculties, state education agencies, school administrators, and local groups. Appendices include the following: (1) Extension of the 1983 guidelines for undergraduate education in chemistry by the Committee on Professional Training; (2) a list of suggested periodicals for chemistry teachers and science departments; and (3) a list of members of the task force. (YP)

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RECOMMENDATIONS FOR THE EDUCATION OF CHEMISTRY TEACHERS

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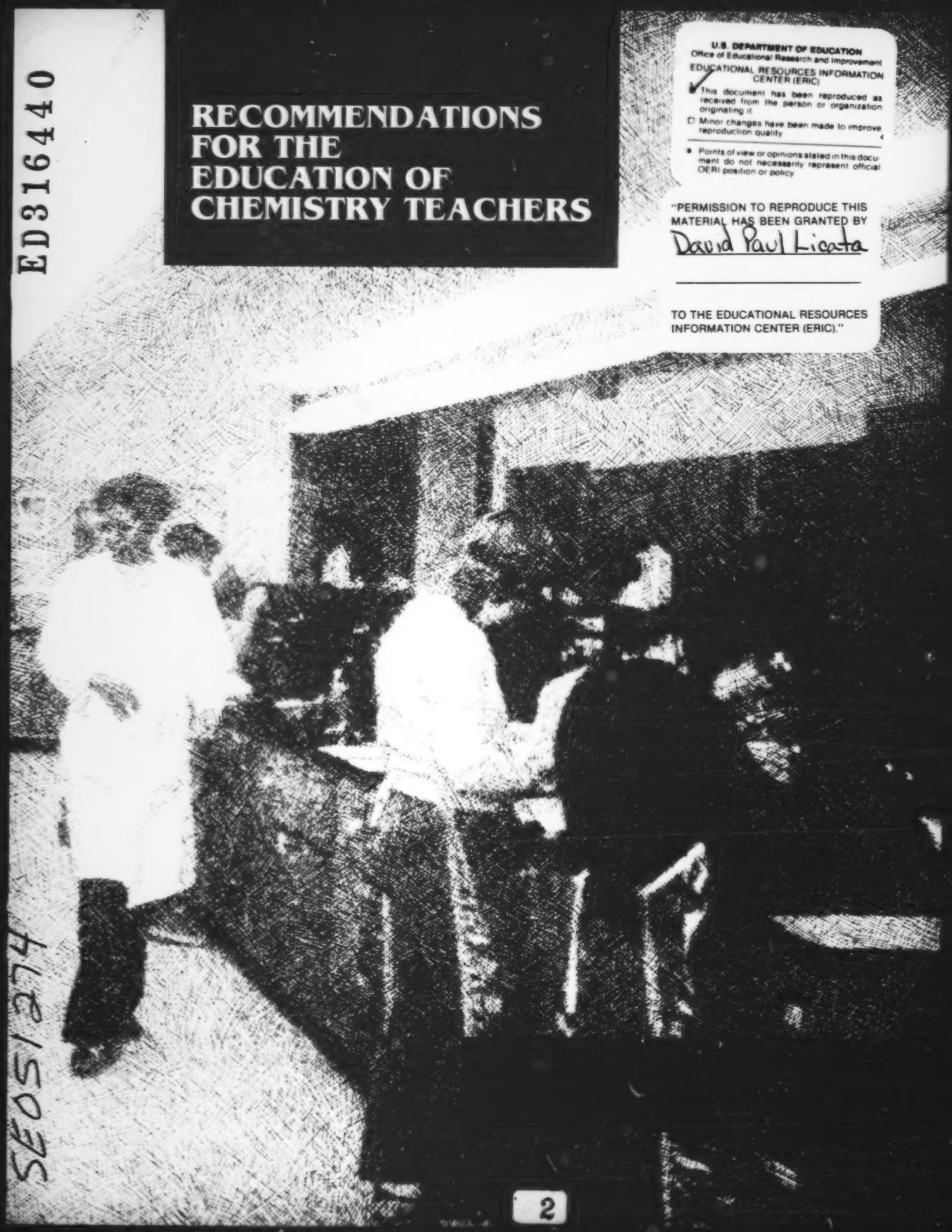

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American Chemical Society
Society Committee on Education
1155 Sixteenth St., N.W.
Washington, DC 20036
1989

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GUIDELINES FOR TEACHER EDUCATION

PRESERVICE TEACHER EDUCATION

These are guidelines, not detailed prescriptions. They will require careful thought to adapt them to the various local situations of a diverse educational system.

Chemistry teachers must be able to manage a chemistry program that has a laboratory emphasis with confidence, enthusiasm, efficiency, and safety; to present and discuss chemistry and answer questions competently; and to benefit from opportunities for continued professional growth. The American Chemical Society (ACS) therefore recommends that prospective secondary school teachers of chemistry have at least the formal college-level academic preparation outlined below.

Chemistry teachers must be able to manage a chemistry program that has a laboratory emphasis with confidence, enthusiasm, efficiency, and safety . . .

For Teachers with a Major or Concentration in Chemistry

- 28 semester hours* of basic instruction in chemistry as defined by the ACS Committee on Professional Training.**
- This includes physical chemistry and at least 300 contact hours of laboratory instruction.
- Advanced and complementary courses to complete an ACS-approved degree.

For Teachers with a Major or Concentration in Another Science

- Courses, including laboratory, in general, inorganic, organic, and physical chemistry.
- Courses that include mathematics, computer science, and physics at a level necessary to support the required chemistry courses.

And For All Science Teachers

Professional education, including

- General preparation for teaching adolescents.
- Instruction and experience in teaching laboratory-centered science.
- Strategies for continuing professional growth.

Prospective teachers also should complete the normal course requirements in the humanities and social sciences.

If teachers are to be able to continue their own professional development and to conduct laboratory-centered programs in chemistry with confidence and enthusiasm, then the teacher preparation curriculum also should include

. . . The teacher preparation curriculum also should include . . . emphasis on problem solving and the application of scientific knowledge and skills. . . .

- On-site secondary school and classroom experiences.
- Strong laboratory and safety components.
- Involvement in the development of experiments, demonstrations, and other hands-on activities.
- Instruction in laboratory management.
- Emphasis on the need for continuing career-long professional growth.
- Encouragement to acquire chemical knowledge and professional teaching skills by means other than formal courses.
- Emphasis on problem solving and the application of scientific knowledge and skills in a variety of everyday situations.

* Semester hours are cited because they are the major medium of academic exchange.

** The ACS Committee on Professional Training guidelines appear in Appendix I.

PROFESSIONAL DEVELOPMENT

The importance of continuing education for chemistry teachers cannot be overemphasized.

For Teachers with a Major or Concentration in Chemistry

Because of the rapid increase in chemical knowledge, its applications, and technological and pedagogical advances, it is essential that even those teachers who meet the preservice requirements outlined in this document pursue further education.

Courses in mathematics, computer science, physics, and interdisciplinary areas are highly recommended.

For Teachers with a Major or Concentration in Another Science

Teachers who do not have the recommended preservice credentials in chemistry as part of their backgrounds should seek opportunities to continue their education and to acquire these credentials as soon as possible.

And for All Science Teachers with Multiple Assignments

Teachers should strive to acquire the recommended undergraduate requirements for a certifiable degree in each discipline they teach.

Programs for preservice education and the continuing education of teachers of chemistry should be reviewed and modified to meet the current needs of the teachers and society.

COLLEGE AND UNIVERSITY ADMINISTRATIONS AND FACULTIES

Appropriate school facilities, materials, and human resources should be available to ensure maximum use of the professional competencies and growth potential of all teachers.

EDUCATION AGENCIES, SCHOOL ADMINISTRATIONS, AND LOCAL GROUPS

Students benefit in many ways from participation in science fairs, visits to museums, and other science activities.

TEACHERS OF CHEMISTRY

In the following sections, actions to implement and support preservice and continuing education programs in chemistry are specified for

- Teachers of Chemistry
- College and University Administrations and Faculties
- State Education Agencies (Boards of education, offices of public instruction, science education departments)
- School Administrations (School boards, superintendents, principals, department chairs)
- Local Groups (Local agencies, industries, citizens' and professional groups)

Teaching chemistry is a demanding professional activity that requires a sound background in content and pedagogy. Incorporating the necessary laboratory emphasis into the chemistry program places additional demands on teachers in terms of technical competence and safety awareness. Moreover, because of the evolving nature of the field, continual personal development is necessary. To foster the professional growth of teachers, ACS has formulated the following list of recommendations.

Teaching chemistry is a demanding professional activity. . . . Continual personal development is necessary.

Teachers should

Recognize that competence in teaching requires continuous education.
To continue their professional development they could

- Strive, when assigned to teach chemistry out-of-field, to complete the undergraduate requirements for a major in chemistry.
- Take advantage of opportunities for growth, in traditional fields (physics, biology, mathematics) and in interdisciplinary areas such as environmental chemistry, biochemistry, earth sciences, chemical instrumentation, computer science, and career and vocational education.
- Investigate alternative teaching strategies and methods. Examine, for example, information on new teaching programs, alternative formats and delivery systems, and relevant current publications in science and science education.
- Use self-assessment instruments, generate detailed plans, and formulate specific goals for continuous professional growth.
- Participate in appropriate college courses, ACS and other short courses, science workshops and institutes, self-study programs, inservice programs, professional meetings, and interclass and interschool activities with professional colleagues.
- Seek summer field opportunities for professional service and expansion of horizons, such as working in the chemical industry, designing and participating in chemistry research projects, developing and testing new laboratory experiments for classroom use, or supplying remedial services for college chemistry students.
- Keep abreast of current developments in chemistry and teaching through journals and other periodicals, books, tapes, films, computer programs, electronic bulletin boards, and special publications in chemistry, science, and science education.

Become active professionals.
Teachers could

- Work directly with school librarians to maintain a well-organized, current chemistry library with components of up-to-date multimedia materials, laboratory manuals, and journals and other periodicals.
- Submit comments, letters, and articles on teaching strategies and ideas to newsletters and professional publications in science and science education.
- Make known to administrators the need for facilities, equipment, supplies, and maintenance programs that are required for the effective teaching of chemistry and for compliance with safety and waste disposal regulations.
- Communicate to college and university faculties and administrators the courses and programs that are needed for continuing education and professional growth.
- Attend local science meetings, conference sessions, and seminars; visit science museums; and engage students in science challenges, science fairs, science olympics, and other science activities.
- Seek out nearby college and university faculty members and chemists in local industries, hospitals, museums, police departments, and government agencies to exchange viewpoints and to arrange personal or class visits to their laboratories. (Often these can be arranged through a local ACS section.)
- Participate in community events that involve chemistry (for example, formulation of environmental impact statements, energy use deliberations, Scouting, geriatric programs, or drug education seminars).
- Join at least one scientific–educational organization and participate in the activities of that group.

Set goals for the achievement of personal growth objectives and review them annually in consultation with immediate supervisors.

Summer conferences and inservice workshops allow teachers to practice new techniques that they will later introduce in their classrooms. At left teachers role-play in a debate on water quality, above partners try a new experiment.

COLLEGE AND UNIVERSITY ADMINISTRATIONS AND FACULTIES

Although this section is addressed to the faculty and administrators of educational institutions in general, it is ordinarily the chemistry and the science education faculties that are specifically concerned with the education of chemistry teachers. Clearly, to discharge this obligation effectively, the faculties of these departments must cooperate in the development and in the conduct of new and existing educational programs. The intent is to encourage the assumption of joint responsibility for the education of teachers with cooperative planning; neither group should view any of the following recommendations as applying solely to the other.

Presidents; provosts; academic vice-presidents; deans of colleges of arts and sciences; deans of sciences; deans of education, curriculum, and instruction; and chairs of departments of chemistry and science education and their respective faculties should

. . . the faculties of chemistry and science education must cooperate in the development and . . . conduct of new and existing educational programs.

For Preservice Education

Establish formal and recognized methods for promoting interaction between chemistry departments and education schools.
Develop mechanisms to

- Involve faculty members from disparate disciplines in team-teaching projects.
- Make joint appointments, including formal and courtesy appointments, between science and education departments.
- Offer joint credit in education and science for courses involving content and pedagogy.
- Appoint proponents for teacher education from chemistry departments, other science departments, and education schools to joint curriculum and program committees.

Introduce modifications to improve the educational value of the curriculum for prospective teachers while preserving the scientific integrity of the programs.
Departments of Chemistry and Education, in consultation with college or university administrators, should

Treat secondary education career preparation with the same concern bestowed on the B.S. in science. . . .

- Liberalize the disciplinary requirements for prospective teachers majoring in chemistry to increase their exposure to related sciences. This could involve relaxing certain requirements for advanced courses both in chemistry and in education in favor of judicious substitutes in other sciences in accord with the guidelines established by the ACS Committee on Professional Training.
- Treat secondary education career preparation with the same concern bestowed on the B.S. in science regarding professional qualifications. For prospective chemistry teachers this could include courses in biochemistry, the history and philosophy of science, geochemistry, environmental chemistry, computer science, and allied health sciences, in their recommended programs.
- Evaluate the chemistry requirements for traditional majors in other disciplines, particularly mathematics and allied sciences, regarding their appropriateness for prospective secondary science teachers who may be required to teach chemistry out-of-field.
- Emphasize laboratory experience in chemistry courses for prospective teachers. The appropriateness and extent of laboratory requirements for the education of prospective teachers should be assessed and, if appropriate, enhanced.
- Provide methods courses for teachers that emphasize laboratory instruction.
- Offer actual, hands-on laboratory experiences.
- Consult with and employ practicing secondary school teachers as members of instructional teams to keep methods courses in close touch with classroom realities.

- Simulate high school situations, particularly the time, space, and facility limitations encountered by teachers engaged in laboratory-centered programs.
- Require prospective teachers to demonstrate their ability to
  - Teach laboratory skills.
  - Locate, choose, adapt, and develop experiments suitable for short laboratory periods.
  - Identify the learning goals of a laboratory activity.
  - Operate laboratories efficiently, including managing inventories, keeping records, maintaining equipment, and ordering supplies.
  - Use safe procedures, including the safe storage of chemicals and the proper techniques for the disposal of hazardous wastes.
- Promote independent study for prospective teachers.
- Engage prospective teachers in projects involving laboratory research, design of curricular materials, library searches, use of computer data bases, and report writing.
- Recommend (or require) a senior thesis for prospective teachers.
- Establish formal, credit-bearing methods of engaging prospective teachers as tutors (upper division prospective teachers tutoring lower division students), as laboratory assistants, and as classroom demonstration assistants. Where credit is awarded, written criteria for evaluation of teachers should be formulated and applied.

Evaluate the presentation of chemistry in college lectures . . . to ensure that proper science teacher role models are in the classrooms.

Evaluate the presentation of chemistry in college and university lectures, laboratories, and resource centers. New teachers often teach in the styles in which they were taught; therefore, steps should be taken at the postsecondary level to ensure that proper science teacher role models are in the classrooms.
Faculty members should

- Illustrate in the college chemistry classroom, by example, that a variety of teaching strategies and techniques can be effective in helping students to learn chemistry.

Include early and continued exposure of prospective teachers to actual classroom teaching experiences.
Schools of Education should

- Schedule structured observations of junior and senior high school science classes in a variety of settings (urban, suburban, rural) early in the undergraduate program of each preservice chemistry teacher.
- Provide early, low-risk, teaching experiences for prospective teachers as tutors for high school students.
- Assign "student teachers" in chemistry only to professionally active, highly qualified teachers.

Laboratories are an essential part of high school chemistry. Teacher preparation should include laboratory work and instruction in laboratory methods and safety.

For Continuing Education

Design appropriate programs and flexible course schedules to meet the needs of practicing teachers.
Departments of Chemistry and Education could

- Offer topical courses on science and chemistry concerns (such as energy, environmental problems, materials abuse and health-related topics, drug information, and issues in science and technology).
- Offer fundamental courses (upper division and graduate courses) in the late afternoon (4:00 or 5:00 P.M.) or evening to accommodate the work schedules of teachers.

- Provide for follow-up of industrial or other field experiences with credit-bearing curriculum seminars.
- Offer summer programs in chemistry departments that are content oriented.
- Teach methods of problem solving, the use of new technology for enhancing lecture presentations, laboratory instruction, and the proper safe use of lecture demonstrations and chemical waste disposal.
- Offer appropriate courses on topics such as basic chemistry from an advanced point of view, frontiers in chemical research, development and growth of scientific thought, and current issues in science and technology.

Design appropriate programs and flexible course schedules to meet the needs of practicing teachers.

Use modern delivery methods to teach science.
Departments of Chemistry and Education could

- Employ consumer technologies (microcomputers, audio cassettes, and videocassette recorders) for home delivery of science topics.
- Explore the use of telecommunication links to convey information to teachers at local sites or in the home.

Share college and university programs and facilities with the secondary teachers in the area.
Departments of Chemistry and Education could

- Arrange special evening sessions for secondary school teachers when seminar speakers, consultants, and other scientists and educators are on campus.
- Sponsor professional days on campus for chemistry teachers and supervisors to discuss common concerns and problems and to familiarize them with facilities, library resources, and other materials and expertise available for their continued use.

Teachers must know appropriate ways to use new technology and how to introduce it in their classrooms.

STATE EDUCATION AGENCIES

Effective science instruction requires that teachers bring to their classrooms a mature understanding of principles of science and a knowledge of classroom methods. The effective teaching of chemistry also entails a thorough understanding of laboratory operation and management. It is a rare individual who can attain acceptable levels of proficiency in all these areas within a four- or even a five-year period. For all these reasons ACS makes the following recommendations:

State boards of education, state offices of public instruction, and state science education departments should

Require continuing education in content and methods for maintaining teacher certification at all levels.
Encourage

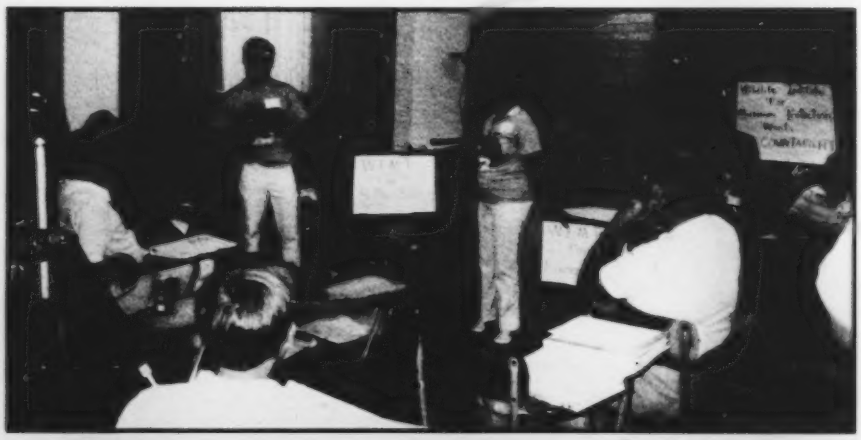
- Teachers with broad field endorsements to add depth to their knowledge in each subject they teach.
- Teachers with a single disciplinary concentration to broaden their backgrounds in other sciences.

Offer inducements at the state level to generate joint efforts by college and high school faculties to organize workshops and summer laboratory programs to improve the teaching of chemistry.

Establish incentive award programs to encourage and support efforts by teachers to improve their courses and to develop themselves professionally.

Institute policies and procedures to enhance the prestige of teaching.

Effective science instruction requires that teachers have a mature understanding of principles of science and a knowledge of classroom methods.



Teachers' conferences, sponsored by professional organizations, school districts, or colleges, help teachers learn about new developments, network with colleagues, and occasionally have some fun.

State support can encourage college and university faculty to sponsor inservice and professional days on campus for chemistry teachers to discuss common concerns and familiarize teachers with facilities available for their use.

SCHOOL ADMINISTRATIONS

Chemistry is a growing, developing, laboratory-centered science. Its dynamic, technology-driven nature places heavy demands on the conscientious teacher to ensure safe, effective instruction and to keep abreast of current developments in content and pedagogical methods. The following recommendations are formulated with these conditions foremost in mind.

School boards, superintendents, local science supervisors, principals, and department chairpersons should

Encourage and facilitate career-long continuing education of chemistry teachers.

- Develop plans with teachers, early in their careers, for continuing education and professional growth, subject to annual review and modification.
- Promote a professional orientation in teachers by supporting participation in the activities of science teacher groups, academies of science, and other professional organizations.
- Sponsor workshops and conferences that bring together teachers from secondary schools, college chemistry departments, and schools of education.
- Permit flexible schedules to allow time for novice teachers to work cooperatively with mentors experienced in laboratory-centered instruction and to attend appropriate scientific meetings and conferences.
- Encourage and support frequent interclass and interschool visits among teachers to promote the development of an infrastructure to support teachers in the field.
- Provide sabbatical and shorter opportunity leaves, tuition assistance, and general financial support for the continuing education of teachers.
- Recognize and reward teachers for outstanding service, for exemplary chemistry programs, and for continuous career development.

Chemistry is a growing, developing, laboratory-centered science.

Teachers, working together on release time provided by the school district, discuss implementation of current teaching methods and provide mutual support.

Support the teachers in the implementation of current methods and technology to promote professional growth.

- Respond to the teachers' identified needs for expendable supplies, equipment, and equipment maintenance.
- Allocate resources to bring laboratories up to modern safety standards and to provide for the proper storage of chemicals and the safe disposal of hazardous materials.
- Restrict maximum class sizes to numbers consistent with safety and suitability for intensive laboratory-oriented instruction.
- Recognize the special demands of laboratory instruction by providing time for preparation, maintenance, and development of demonstrations and laboratory activities.
- Employ paraprofessionals to assist in laboratory-centered programs.
- Provide resource and reference materials to support instructional programs in chemistry.
- Make texts available to support the teacher in areas such as general chemistry, organic chemistry, inorganic chemistry, biochemistry, environmental chemistry, analytical chemistry, and physical chemistry.
- Provide school or department libraries with subscriptions to publications in chemistry and science education for teachers, chemistry publications directed to students, and appropriate materials describing career opportunities in chemistry and chemistry-related fields.
- Provide computer hardware and software for computer-assisted instruction, for laboratory management, for inventory control, and for computer-interfaced experiments. Funds for acquiring and updating software for student and teacher use should be provided.

Recognize the special demands of laboratory instruction . . .

Industry, colleges, and universities can provide opportunities for teachers to participate in research and broaden their experience in chemistry.

LOCAL GROUPS

The ultimate responsibility for effective education rests on the shoulders of local citizens. Moreover, rapid technological advances and the current explosion in knowledge require that schools and teachers, particularly in the sciences, must engage in continuous renewal. Much can be accomplished by local initiatives, both within and outside of the educational establishment. ACS recommends the following steps:

Local agencies, industries, and citizens' groups, including alliances of industrial and scientific organizations, local sections of national and state societies, coalitions of concerned citizens, parent–teacher–student organizations, are urged to:

Facilitate effective up-to-date science instruction in the schools by providing support, both financial and contributions-in-kind.

- Offer incentive awards for teachers and students to excel in science activities.
- Provide funds for summer workshops for secondary school teachers.
- Establish or expand speakers' bureau services to secondary school classes and teachers' groups.
- Present gifts of surplus capital and expendable equipment to school chemistry laboratories.
- Establish minigrant programs as direct funding sources for teachers to acquire equipment and supplies to introduce modern and newly learned technology in the classroom.

Initiate programs for sharing industrial, government, and university expertise with chemistry teachers.

- Offer the advice and counsel of industrial safety and waste disposal experts; provide speakers on such topics as the role of science and technology in industry.
- Include teachers on mailing lists that inform practicing chemists of forthcoming professional meetings, seminars, and conferences.
- Set up electronic networks of teachers with industrial and university mentors for effective communication and transfer of knowledge.
- Provide direct access by computer to area library resources.
- Help teachers collect relevant materials for the classroom and for their own personal enlightenment.

Recognize the mutual benefits of summer employment programs for secondary school chemistry teachers in industrial environments. Such programs

- Update and upgrade teachers' knowledge and keep teachers in touch with advancements so they can communicate to students the excitement and satisfaction of employment in the chemical industry.
- Help teachers learn from the industrial experience new approaches for effective instruction (such as cooperative or group work, communication skills, and problem solving).
- Encourage competent teachers to remain in the classroom by providing them with productive summers, practical learning experiences, and additional income.
- Apprise employers and local citizens of the value of teachers as professionals and contributors to society.

Aid, in every way possible, in the enhancement of the professional status of teachers and the teaching profession.

Appendix I

Committee on Professional Training—Extension of the 1983 Guidelines

PREFACE

A curriculum in compliance with the 1983 CPT Guidelines remains a sound approach to undergraduate education in chemistry. However, chemistry continues to develop in interdisciplinary directions. Accordingly, institutions are encouraged to design new programs in chemistry with some diversification of emphasis. In addition to the certifiable chemistry degree described in the 1983 Guidelines, approved departments may also request approval for certifying undergraduates who have completed any of the alternate degree programs described below.

CORE TOPICS

There is a core of knowledge requisite for any professional in the various chemical sciences. Undergraduates should have a minimum of 28 semester hours of basic instruction with comparable emphasis on

- Elementary and intermediate inorganic chemistry
- Elementary chemical analysis and instrumental methods of analysis
- Fundamentals of organic chemistry, including bioorganic chemistry
- Principles of physical chemistry, including thermodynamics and equilibria, chemical kinetics, introductory quantum and statistical mechanics, and spectroscopy

The 28 semester hours of study should include the equivalent of 7 semester hours (approximately 300–350 contact hours) of laboratory instruction in

- Synthesis and characterization of inorganic and organic compounds
- Elementary chemical analysis and instrumental methods of analysis
- Experimental physical chemistry

Laboratory instruction should include practical experience with instrumentation for spectroscopy, separation techniques, electrochemical methods, and computerized data acquisition and analysis.

A more extensive discussion of guidelines for laboratory experience may be found in the original 1983 Guidelines booklet.

Advanced and Complementary Courses

The student should have some advanced or complementary courses that build on the core material and focus on the particular interests or degree emphasis, as indicated below:

CHEMISTRY	At least two advanced courses and an additional 150–200 hours of laboratory, which may be research culminating in a comprehensive written report.
CHEMISTRY/ BIOCHEMISTRY*	Two semesters of biochemistry including molecular aspects of cell biology and genetics; one semester of laboratory in biochemical methods; and an advanced course, which may be research culminating in a comprehensive written report.

*This degree program, developed in cooperation with the American Society of Biochemistry and Molecular Biology, has been endorsed by ASBMB.

CHEMISTRY/ POLYMERS	Equivalent of two semesters of polymer science including introduction to materials science, and organic and physical chemistry of polymers; one semester of polymer science laboratory; and an advanced course, which may be research culminating in a comprehensive written report.
CHEMISTRY/ EDUCATION	Chemistry (science) teaching methods taught in cooperation with the chemistry department; three courses to provide breadth in science; and individual and study at the senior level.

The programs are described in terms of minimum requirements for certification. All approved departments must offer a certifiable chemistry degree.

A Comment on General Chemistry Courses

The first-year experience in undergraduate chemistry varies widely among institutions, depending on the profile of incoming students, the institutional mission, and curriculum structure within departments. The core topics discussed above may be covered partially in courses designated as general chemistry. Some institutions, however, are exploring alternative approaches in the first course(s) to provide breadth. Therefore, the Committee has chosen to define required content rather than to designate courses by traditional names that may no longer be appropriate. Departments will be asked to provide information regarding the distribution of core topics in the various courses, including a general chemistry course.

Suggested Periodicals for Chemistry Teachers and Science Departments

Appendix II

American Chemical Society

ChemComments

Chemical & Engineering News

Chem Matters

CHEMTECH

Chemunity

Environmental Science & Technology

WonderScience

American Chemical Society
1155 16th Street, N.W.
Washington, DC 20036

National Science Teachers Association

Journal of College Science Teaching

Science & Children

Science Scope

The Science Teacher

National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, DC 20009

The American Biology Teacher
National Association of Biology Teachers
11250 Roger Bacon Drive
Reston, VA 22090

Chem 13/News
Department of Chemistry
University of Waterloo
Waterloo, ON N2L 3G1
CANADA

Journal of Chemical Education
Subscription & Book Order Department
20th & Northampton Streets
Easton, PA 18042

Journal of Chemical Education: Software
Department of Chemistry
University of Wisconsin at Madison
Madison, WI 53706

The Physics Teacher
American Association of Physics Teachers
Graduate Physics Building
State University of New York at Stony Brook
Stony Brook, NY 11794

Science
American Association for the Advancement of Science
1333 H Street, N.W.
Washington, DC 20005

Science News
Subscription Department
231 West Center Street
Marion, OH 43302

Scientific American
Subscription Manager
415 Madison Avenue
New York, NY 10017

Self-Assessment Materials

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II. Our School's Science Teacher
III. Science Student/Teacher Interactions in Our School
IV. Facilities and Conditions for Science Teaching in Our School
Report Form, 2 copies
Complete self-assessment package, including one copy of each of four modules, two report forms, and an introductory preface also available.
For ordering information, contact:
National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, DC 20009
Phone (202) 382-5800

Appendix III

Members of the Task Force to Revise the 1977 Guidelines

The American Chemical Society Committee on Education first released its "Guidelines and Recommendations for the Preparation and Continuing Education of Secondary School Teachers of Chemistry" in 1977. Stanley Kirschner chaired the steering committee that developed the 1977 Guidelines; Jay A. Young chaired the writing committee. The Task Force to Revise the 1977 Guidelines was appointed in 1986 and began work in 1987.

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